# AGRICULTURAL ENGINEERING

IN THE

# BOMBAY PRESIDENCY

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# AGRICULTURAL ENGINEERING IN THE BOMBAY PRESIDENCY.

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# AGRICULTURAL ENGINEERING IN THE BOMBAY PRESIDENCY.

## CHAPTER I.

### INTRODUCTORY.

The relation of engineering to agriculture.

THE function of engineering in the development and improvement of agriculture has of recent years received an ever growing amount of attention. In a comparatively speaking backward agricultural country, such as India, the skill of engineers has obviously a wide field of actual and potential activity. Water is one of the first essentials of cultivation; in a country, therefore, where rainfall is capricious, artificial methods of ensuring an adequate supply must be adopted. The engineer's chief device for providing water is of course the construction and maintenance of irrigation canals, but this is a subject outside the scope of the present pamphlet. Well and river irrigation, however, is a valuable and in some cases the only practicable alternative to canal irrigation, and improvement in this direction is one of the most important branches of agricultural engineering proper. But the provision of such irrigational facilities immediately leads to a second engineering problem, namely, that of devising the most economical method of distributing the water on to the land, and entails a study of pumping plants and sites, with special reference to the possibilities of various types of power-plants. Then, again, the application of power to other agricultural operations, such as ploughing, immediately suggests itself, while certain phases of land improvement, such as

field terracing and salt land reclamation, can also present problems which demand the expert advice and aid of an engineer. The improvement of agricultural implements is a sister subject in which the co-operation of engineering and agricultural experts is highly desirable.

**Design of this pamphlet**

The Government of Bombay believe that a brief review of what has been and is being accomplished in the domain of agricultural engineering will prove both interesting and instructive, and that publicity may help to popularize the department concerned and facilitate its work. But before dealing in detail with its various activities, it will be well to sketch briefly its origin and development.

**Initiation of the Agricultural Engineer's Department.**

Until 1909 the work of supervising well boring and pumping plants, and indeed the whole engineering aspect of agriculture, had been in the hands of the ordinary staff of the Agricultural Department. But in that year it was finally recognized that the Department had gone too fast, at least in the matter of power-plants, without adequate expert advice. Accordingly, towards the end of the year, the services of Mr. A. A. Musto of the Public Works Department were lent to the Director of Agriculture, and that officer at once set to work to organize a special engineering branch of the Department. In three years such valuable progress was made that the appointment of Agricultural Engineer was made permanent. Its present incumbent, Mr. W. M. Schutte, is a specially selected expert and took charge of the post in January 1913. His work may roughly be divided into two main classes—advisory and executive. The advisory work consists of answering enquiries, giving advice, and preparing estimates for

**The post made permanent**

**Advisory work**

various kinds of projects, in pursuance of which a large amount of touring has to be done, as surveys of sites are often necessary preliminaries to the giving of advice. The importance of the advisory work can be gathered from the fact that in the year ending 30th June 1913 no fewer than 157 enquiries were received, of which 91 were in connection with pumping, and 93 sites were surveyed. In addition to this the Agricultural Engineer endeavours to give practical assistance to land-owners who already possess any form of agricultural machinery. He gives advice on the spot, he sends expert mechanics to investigate and set right defects, and undertakes, on business terms which will be described later, the erection of plants for private individuals. He is also constructing a workshop and training school which will serve a two-fold object. In this shop any person interested in agriculture, and particularly those who are cultivators, will be taught, for a nominal fee, the proper way of attending to power-plants and improved agricultural implements. The aim will be not to convert them into trained engineers, but to give them sufficient practical knowledge to enable them to use their machinery to the best advantage, to effect minor repairs and to set right temporary stoppages. At present, for the lack of this elementary knowledge, a power-plant may remain idle for several weeks before a mechanic can be procured to set it in working order. In the second place it is intended to give a rather more complete training to a class of men from whom capable drivers can be selected both for privately owned and Government plants. Those who obtain Government employ will also be trained in erection work and in the location of engine troubles. Thus there will come into being a class of skilled men, the present scarcity of whom seriously handicaps both the Department and the progressive cultivator.

A training workshop.

Executive work.

This account of the workshop and training school has perhaps trenched on the executive side of the Agricultural Engineer's functions. His duties under this heading consist of the purchase and actual erection of plants, both Government and private, the repair and supervision of existing Government plants, the investigation of new types of machinery, and the solution of such other problems as the Agricultural Department may set him.

This general description of the work of the Agricultural Engineer will only give a bare idea of the scope of his department. In the succeeding chapters an endeavour will be made to trace in greater detail some of the results already achieved and the developments anticipated in the future.

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## CHAPTER II.

### WELL BORING.

The Gujaráti "jumper."

IN the year 1907 the Agricultural Department took up the subject of well boring in Gujarát in earnest. The indigenous tools were first tested, with the addition of a few implements which were calculated to assist the work. With these tools the *modus operandi* is briefly as follows:—A pulley is erected over the well to carry a stout rope with a long iron bar attached. This bar is armed with a chisel and is worked inside a 3-inch pipe by coolies on the rope, who jump the bar up and down inside a vertical pipe. The tools are therefore ordinarily known as "jumpers." When a certain amount of the soil at the bottom of the pipe has been broken up by the jumper, the bar is pulled up, the chisel is removed, and a mud shell substituted. When the loosened soil has been removed, the chisel is again set to work. This process is constantly

repeated, and as the excavation gets deeper fresh lengths are screwed on to the iron bar and fresh lengths of piping on to the existing piping, which has to be forced down into the bore. By this elementary process borings were made which extended in some cases to 70 or 80 feet below the bottom of wells already 50 feet deep, the object being to tap a supply of sub-artesian water. As regards the efficiency of the tools it was found that they work very slowly, and that the average cost of boring amounts to just over Rs. 3 per foot excluding the cost of piping. The worst point about them, however, is that accidents are very likely to occur which render useless all the previous work done in the well. The principal accidents which occur are these :—

Weak points.

(*a*) In changing the chisel for the mud shell and *vice versâ* or in screwing on new lengths of the iron bar the work is apt to be done carelessly, with the result that the tool or a length of bar falls off into the bore hole ; and when the bore hole is over 50 feet deep, it is almost impossible to retrieve them.

(*b*) In hammering down the pipe it is liable to burst at some of its couplings.

In 1908 the overseer who had been in charge of the Gujarát jumper experiments was deputed to Cawnpore to study the well boring operations in the United Provinces and learn the use of the local apparatus ; and on his return started work with a set of the Cawnpore tools which speedily demonstrated their superiority over those of the Gujaráti type. The *modus operandi* with the Cawnpore tools is shortly as follows :—The general principle of breaking up the soil by a chisel worked by coolies on a rope over a pulley

Introduction of Cawnpore tools.

is the same; but in this case *two* vertical pipes are used. The larger pipe ($2\frac{1}{2}$ inch) is kept full of water, and inside it a smaller pipe ($1\frac{1}{4}$ inch) is jumped up and down. The smaller pipe has attached to the bottom of it a chisel, in such a way that the bottom end is kept open and admits the water, while the top end is fitted with a sludger. The chisel breaks up the soil, which mixes with the water and in this state is forced up the small pipe and ejected at the top by the sludger. The advantage of this method is that it obviates the necessity for the use of the mud shell and its constant changing for the chisel. This both saves time and greatly decreases the risk of dropping the tools into the bore. Further, as the excavation is carried out in wet instead of in dry ground, the large pipe sinks with little or no hammering, and thus the risk of bursting it at its couplings is eliminated. The only advantage which the old tools possess over the new is that they can be used in soft *muram;* the Cawnpore tools can only tackle earth or sand. There are, however, large areas in Gujarát which are suitable for the use of the Cawnpore tools. The average cost of boring during the 1908-09 operations with the new tools was only Re. 1-7-1 per foot exclusive of the cost of piping, which in the case of successful bores only averaged Re. 1-4-0 per foot.

**Superiority of Cawnpore tools over the Gujaráti.**

The new tools speedily superseded the old tools in popular estimation. In the year 1909-10, 55 borings were made with them, of which 22 were unsuccessful. This was not due to any failure of the tools, but to the fact that in some cases rock was met with, and in others the water was too deep for the tools to reach at a remunerative rate. These borings were mostly carried out on the understanding that the well-owner should provide the labour in all cases, and, if

**Increased borings in Gujarát.**

water was struck, should also pay the cost of the piping and the *mukádam's* wages. Where water was not obtained, Government paid the *mukádam's* wages, and were at liberty to remove the piping. In all cases no charge was made for the use of the tools or supervision. In the following year (1910-11) the well boring operations in Gujarát showed a considerable advance. An area was found in the Borsad táluka where a good supply of sub-artesian water can be tapped with fair certainty at a depth of about 100 feet below ground-level. The men engaged in the work had become more expert and were able to go down without difficulty to greater depths than 100 feet. The Department had eight plants working during the year, while the District Local Boards of Kaira and Surat bought sets for their own use. In the year 1911-12, with the impetus derived from a failure of the monsoon, the Department had 28 sets at work, the Local Boards 14, and Baroda State 18, while 14 were purchased by private owners. Thus the Bombay Agricultural Department may fairly claim that it has introduced a cheap and improved form of boring into the whole of Gujarát.

**The Agricultural Engineer's survey of the question.**

Meanwhile the Agricultural Engineer had been surveying the whole boring question. He examined the working of the tools used in Gujarát and suggested various improvements. He also proposed that a trial should be made with power-driven boring plant which would be able to drill through rock where necessary instead of being limited to boring in earth and sand, and the Kaira District Local Board actually ordered one such plant through him. In the year 1912-13 the entire supervision of the boring work was transferred to the Agricultural Engineer, with the exception of the work in Kaira, which was taken over by the District Local Board and placed under a special staff. The results of placing boring

operations under an expert were speedily apparent. Mr. Musto reverted to the Public Works Department in November 1913, and soon after completed and patented a new type of boring machine which can be worked either by hand labour, bullock gear or motor. This machine has been tested under severe conditions, and proved itself capable of boring, not only through soil and *muram,* but also through the hardest rock. It was tried at Jeur Station on the G. I. P. Railway in a disused well of trap-rock. The strata was exceedingly hard, but 50 feet were bored in 16 days at a cost of Re. 1-5-5 per foot. The special importance of this invention lies in the fact that it renders boring in the Deccan not only possible but practicable. Mr. Schutte, the present Agricultural Engineer, is continuing his tests with this machine and designing special tools which he hopes will reduce the cost of boring and eventually revolutionize hand-boring in the Presidency. He is also carrying out experiments with blasting, for which he is training a special staff, and foresees possibilities in the use of the patent Musto machine followed up by blasting.

Mr. Musto's patent boring machine.

Its great possibilities.

It should be mentioned that the patent borer was also tried in Gujarát, and was found to be as successful in soft soil as in hard rock. In very soft soil, it bored at least three times as fast as the Cawnpore tools or about 30 feet per day. The Director of Agriculture is replacing the Department's Cawnpore sets with the patent machines and already thirteen of these machines are owned by the Department. Meanwhile the former are still doing good work in Gujarát; only progress is very much slower than with the Musto borer. The petrol power-borer selected by the Agricultural Engineer for the Kaira Local Board has started work, and

has shown itself capable of boring in stiff clay at a cost of Re. 1-2-2 per foot.

The water-finder

Now it is obvious that however perfect be our methods of well boring, they will, nevertheless, prove abortive if there be no water at the bottom of the bore. This is a fate which may equally befall the expert or the novice, and entails a certain percentage of failure and of wasted expense. To remedy this state of affairs the Department for several years past has been experimenting with an automatic water-finder manufactured by Messrs. Mansfield & Co. of Liverpool. This is a rather costly and delicate instrument, which, by the deflection of a magnetic needle, shows, according to its makers, whether there is water beneath the spot where it may from time to time be located. The experiments of the Department tend to prove that its makers' claims are not unjustified, and that while a certain amount of practice in using it is necessary, the instrument is not really difficult to employ. The actual observations take time and demand patience rather than skill, but the interpretation of the indications obtained requires considerable experience. Another difficulty has been the impossibility of verifying its indications in more than a few instances by ordinary digging. This has been especially the case in areas of trap-rock.

Its possibilities in conjunction with the patent borer.

The use, however, of Musto's patent boring plant in conjunction with the water-finder has been attended so far with great success, and several bores have been put down on the basis of its indications. In three of these, up to the time of writing, a sub-artesian supply was tapped, and in one instance the water rose a distance of 60 feet up the bore. But it must be noticed that the finder appears to be of no use except in

detecting *flowing water*. It gives no indications whatever in Gujarát where water is known to exist but where it is probably not flowing. In the areas where water is probably in fissures and flowing, the water-finder promises to be an important adjunct to the work of the boring plant in indicating the most likely sites for successful work. It may indeed eventually be possible to carry out a regular water survey, so that the rayat who wishes to dig a new well can be told almost for certain whether he will strike water or not. Similarly, it might become possible to sink deep bores with the practical certainty of tapping artesian water. The improvements, both in agriculture and in rural sanitation, resulting from a more abundant water-supply, are too obvious to need comment. Experiments with the water-finder and boring operations are still in progress and arrangements are being made for an extensive boring campaign next fair season, when it is hoped that the cultivators will make full use of the new rules and boring machine.

Some results.

Since the year 1907 the Agricultural Department has received no less than 1,600 applications for boring and has taken in hand 383; 247 of these holes have been successful, 25 partially so, 104 were failures and 9 abandoned before completion. It is interesting to note that 1,000 of these applications were handed over to the Kaira Local Board in 1912, when that body took charge of the boring operations in that district. As regards the remaining 217 applications received by the Agricultural Department, work is in progress in the case of 25 and the rest may be considered idle enquiries. By far the greater number of these applications have been received since the famine year of 1910, and it is anticipated that with the introduction of improved rules, a machine that will bore in any strata, and the use of the water-finder to locate

currents, an impetus will be given to this very important section of the Agricultural Engineer's work. Bore-holes have recently been made in the Deccan trap and the results have been highly satisfactory. In every case, but one, where a boring has been made, water has been found, and in four cases sub-artesian water was struck, varying in capacity from 120 gallons to 1,500 gallons per hour.

Volume of water obtained.

Probably the most striking feature of these results is that the water tapped is not stagnant but flowing. Take, for instance, a bore-hole 100 feet in depth and 3 inches in diameter. Such a hole, when full, holds approximately 30·5 gallons of water, a quantity useless either for irrigation or household purposes, but when flowing yields a supply of real value for both these purposes. This can be proved by instancing bores taken at Karmála, Sholápur district, with a flow of 1,500 gallons per hour, at Mohal, Sholápur district, with 1,500 gallons per hour, at the Bund Garden Road, Poona, with 720 gallons per hour and at Ganeshkhind Road, Poona, with 130 gallons per hour.

There is, of course, a certain percentage of failure, but with the help of the water-finder and a machine that will penetrate effectively and to any depth the hard trap-rock hitherto considered incapable of profitable boring, it is possible to tap many inexhaustible supplies of water in an area where water is particularly needed.

An expert committee.

The Agricultural Engineer anticipates that in one year's time he will be in possession of some very valuable data with regard to the underground water-supply of the Presidency. Moreover, Government have recently appointed a committee of experts to advise them on the following questions:—

(1) what steps are necessary to co-ordinate the operations of the Agricultural and Sanitary Departments, both of which have for some time past been busily engaged in searching for new or improved sources of water-supply by well-boring;

(2) whether the results secured justify the continuance of experiments on a larger scale;

(3) if so, what type of tools and machinery are best adapted for the various geological formations met with in different parts of the Presidency;

(4) whether a sub-soil survey is required; and

(5) generally, what can be done to facilitate the supply of water from artesian sources, both for agricultural and sanitary purposes.

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## CHAPTER III.

### PUMPING.

THE rise in the wages of labour and in the cost of working bullocks renders the old-fashioned method of raising water from wells increasingly expensive. The Agricultural Department has done much to improve and popularize, in the chain pump, Persian wheel and other mechanical devices, more efficient methods, but there can be little doubt that a great future lies open to the more advanced cultivators who are ready to follow the Department's lead and irrigate by means of power-driven pumps. It must, however, be understood that the following description of that branch of the Agricultural Engineer's work, which concerns itself with this most important subject, deals with the raising of water by mechanical means, not only from wells, but also from such sources of supply as rivers. The latter, in fact, afford the

The case for power-pumps

greater scope for power-driven pumps; comparatively few wells contain sufficient water to render possible and paying the installation of a large and powerful pump, whereas a river with a perennial supply can give constant employment to such a pump and can irrigate a large area of land, and of course the bigger the area commanded, the more economical is the installation.

**The Agricultural Department's early experiments.**

In August 1908 the Agricultural Department obtained the services of a mechanical assistant, and several oil-engines and pumps were purchased for trial. Such pumping plants had already been at work in various parts of the Presidency for some years past, and it had been demonstrated that an oil-engine would lift water from a well with a really good water-supply at roughly half the cost of bullock-power. The object of the new venture was to see how far such pumping plants were suitable for lifting water at an economic rate from rivers in the Deccan. Some installations were accordingly made, but in 1909 the Director of Agriculture came to the conclusion that expert advice was necessary in regard both to the existing installations and to the erection of new plants. The appointment of Mr. Musto as Agricultural Engineer at the end of that year made that expert advice available, and it was soon found that most of the engines were fixed badly and running badly, and that some had even been seriously damaged. But in the year ending 30th June 1911, not only had the eight plants owned by the Department been examined and placed in thorough working order, but one new Government and three private pumping installations had been completed, and three Government installations and one private installation were in course of erection. The Agricul-

**The need of expert advice: appointment of an Agricultural Engineer and its results**

tural Engineer also prepared a note on 'Pumping and other Machinery', which was published as Leaflet No. 8 of 1912. In the year 1911-1912 another big advance was visible. Two of the Government pumping plants were sold to the owners of the land on which they were fixed, a fact which in itself is a proof of their efficiency and of their educative effect. Two more Government plants were either completed or under construction, while no fewer than six private plants were wholly or partially erected. In 1912-1913 the Agricultural Engineer was chiefly occupied in completing the work begun in the previous year, in erecting the workshop and experimental machinery, in making tests at the various pumping plants already erected, in installing five power-plants on Government farms, and in extensive touring throughout the Presidency to get in touch with all the problems connected with power-pumping. In addition to this an entirely new steam boiler plant was installed at Ode in the Kaira district, which solved one of the problems of deep well irrigation.

Publication of a note on 'Pumping and other Machinery'.

Recent work

But quality is a fairer test of the advance made than quantity, and in order to show the continuous improvement that the Agricultural Engineer is effecting in pumping installations a few concrete instances may be quoted. In 1911-1912 a pumping plant was erected at Nangaon in the Poona district, on the bank of the Bhima river. The peculiar difficulty to be overcome was the frequency with which floods occur in the river, coupled with the fact that irrigation is often necessary at the time of their occurrence. The highest floods rise as much as 40 feet above low-water level, and if the pumps were placed above flood level, the lift during

The Nangaon pumping plant

the absence of floods would be beyond the suction limit, and this would be detrimental to the economical working of the plant. Two sets of pumps were, therefore, installed, one set half way down the bank and the other above flood level. In the dry weather and when there is no flood, the lower set is used; but as soon as the water rises up to its pumps, the upper set is connected with the engine and pumping continues without a break. At Ranjangaon, a few miles from this installation, another plant was privately erected on the old plan, whereby the pump works from a well constructed in the high bank of the river and connected to the river by a pipe or masonry culvert. The conditions with which the two plants had to deal were almost identical, except that the total lift at Ranjangaon is only 43 feet as against 47 feet at Nangaon. At the latter place a 37-horse power gas-engine and expensive turbine pumps were installed in order to obtain high efficiency, while at Ranjangaon the oil-engine was of 25-horse power only and the pump comparatively small. The total cost of the Nangaon installation was Rs. 22,200, of which only Rs. 4,200 or 19 per cent. was devoted to fixing and housing machinery and servants' quarters. The total cost of the second plant was Rs. 14,000, of which no less a sum than Rs. 9,000 or 64 per cent. was expended on fixing and housing machinery. The total cost of working per annum, including liberal allowances for interest, depreciation and repairs, is almost identical at the two places, being Rs. 6,000 at Nangaon and Rs. 100 less at Ranjangaon, but the quantity of water obtained at Nangaon throughout the hot weather is $2\frac{1}{2}$ times the quantity obtained at Ranjangaon, and when the upper pumps can be worked this is increased to nearly four times that amount. In other words, the cost of the water at Nangaon is only 40 per cent. of the cost at Ranjangaon. Moreover, the cost of construction at Nangaon could have been cut down considerably by less expenditure

on *pucka* building and spare parts. This was not done, however, as half the object of the installation was to prove that it pays to use the best materials and the best machinery. The other point that this installation succeeded in proving was that the design and location of pumps and engines demand an expert's attention. Unfortunately the working of this plant has been circumscribed owing to the setting up of salt efflorescence in a section of the irrigated area; nevertheless, its lessons remain the same.

**Lessons of the Nangaon installation**

Another instance of the improvements effected by the Agricultural Engineer is seen in connection with small pumps for use in wells. Up to the year 1911-1912 a three-inch centrifugal pump was the smallest that could be recommended, as the next smallest size on the market - the two-inch -was a very inefficient machine. But comparatively few wells contain sufficient water to keep a three-inch pipe regularly at work. The representations of the Agricultural Engineer induced an important firm of manufacturers to place on the market a $2\frac{1}{2}$-inch pump, which appears to be much better designed than the two-inch pump and almost as efficient as the three-inch. The same firm was also persuaded to re-design all their standard sizes of pumps with a view to obtaining a higher efficiency within the limits in which they are generally worked for irrigation pumping. As a result, the firm now offers, at the same price as the old-type pumps, a much improved high efficiency pump which is admirably suited for irrigation work on lifts up to 50 or 60 feet. In fact, where the water-supply is sufficient, the total lift not more than 50 feet and the area to be irrigated 20 acres or upwards, well-irrigation by means of centrifugal pumps may safely be called a paying concern. Further

**Improved types of small pumps**

improvement may still be expected, as for this class of pumping, and especially in the case of a well or river having a fairly quick rise and fall, the Agricultural Engineer is introducing an entirely new design of pump which will obviate the necessity of making any adjustment for the various levels during pumping. With this design of pump it will be immaterial whether the pump itself is under or above water. This is obviously an improvement on the old horizontal type of pump, especially in regard to well-irrigation.

**Portable oil-engines.**

The chief obstacle to the extension of power-pumps to wells in the Bombay Presidency lies in the fact that the majority of wells do not contain a sufficient supply of water to enable the plant to work full time. The improvements in boring that have already been described, and the use of pumping engines to drive other machinery, such as sugarcane crushers, which will be discussed in the following chapter, remove this difficulty to a considerable extent. But the Agricultural Department has still another method of dealing with the problem. It has introduced a portable oil-engine which can be moved from one well to another. The advantages of this are obvious, and it might well be possible for some of the more intelligent cultivators in a village to purchase such an engine for their common use. A $2\frac{1}{2}$-inch pump of the type described above worked by an engine will irrigate any given area of land at a very much faster rate than any non-power plant, and there would thus be little danger of one cultivator's field being kept waiting over-long while the engine was being used to irrigate one of his partners' field. That such co-operation is not impossible is shown by an instance quoted in the Land Revenue Administration Report of 1912-1913 from the Chikhli táluka of the Surat district. Here a power-driven pump has been

at work on the bank of a river for four years past. There are seven sharers in the concern, who provide the working expenses in proportion to the area of their irrigated land.

**How to obtain the Agricultural Engineer's advice and aid.**

Reference has already been made to the importance of obtaining expert advice before purchasing or erecting any power-plant. Leaflet No. 8 of 1912 explains the aid which the Agricultural Engineer is ready to give and the proper method of obtaining it. On written application being made to him at Poona he will, if sufficient particulars are supplied, at once give advice and send estimates. If the particulars supplied are inadequate, he will send forms to be filled up, in which all the necessary details are shown. Then, after an inspection of the site if necessary, he will give the advice required. This applies to enquiries regarding pumping both from rivers and wells.

**Progress up to date.**

It may at first sight appear that, in spite of the Agricultural Engineer's efforts, the introduction of power-pumping is progressing very slowly. Such a view, however, would hardly be correct. The number of pumping plants actually erected does not rest entirely with the Agricultural Engineer, for it is computed that there are some 130 of these plants already existent in the Bombay Presidency, which represent the power that can be developed by 2,000 bullocks. The Agricultural Engineer, however, is always ready to erect private plants if so requested, but a person who accepts his advice is at perfect liberty to get the work done privately. The real point to consider is the number of enquiries which he receives, and pumping enquiries alone from the Presidency proper reached the satisfactory figure of 91 in the year 1912-1913. In 85 cases sites were surveyed; five plants have already been designed, erected and tested by the Agricultural

Engineer, and eight others have been designed and are under erection. In each of the five cases where the work is complete the cultivator himself has been trained to drive and attend to his own plant. During the year 1913-1914 the number of enquiries rose to 131, and it is anticipated that many of these will mature. Every new plant erected is in itself an object lesson and every enquiry answered must have some educative effect.

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## CHAPTER IV.

### POWER PLANT IN GENERAL.

REFERENCE has already been made to the fact that there must be some economic loss if a pumping engine cannot work full time, as, for example, when the water in the well is deficient or when the area irrigated is too small and thus below the capacity of the pump. Much, if not all, of this loss can be avoided by setting the engine to work other machinery when it is not actually working the pump. Such machinery comprises sugarcane and oil-seed crushers, small cotton gins, grinding mills, rice hullers, *bhusi* preparing machinery, maize shellers and the like. While, therefore, the discussion which follows is primarily concerned with the different types of agricultural machinery which can best be worked by power-plants, and not with the question of working several with one engine only, it must be borne in mind that any of the seven kinds of machinery just mentioned are especially suitable to being fitted to the engine of a power-pump which cannot work full time. Moreover, if the engine is sufficiently powerful, it is possible to work more than one machine at a time. A striking example of this is quoted in the Land Revenue Administration Report, 1912-1913, from the Párdi táluka of the Surat district, where a cultivator has

Pumping engines can be used for other purposes

installed a pump, a sugarcane crusher and two oil presses together with an engine which can drive the pump and one of the other machines simultaneously.

**Crushing sugarcane by power.**

Power sugarcane crushers have attracted the attention of the Agricultural Department for many years past, and it has been abundantly proved that they can be run much more economically than bullock-driven mills. Five years ago an independent cane-grower had his cane crushed by an oil-engine crusher at the Mánjri Government Farm and testified that the work took three weeks instead of three months; that he thus saved the keep of 22 bullocks for three months; and that he obtained 8 per cent. more juice than usual. Other competent observers estimated the output of juice at 11 per cent. over that obtained by the old method. It was generally agreed that the power-crusher does the work cheaper and gives a better juice extraction. The saving in labour is particularly important in view of its scarcity in some parts of the Presidency. In fact, in 1908-1909 the difficulty of obtaining labour in the crushing season was so great that a large part of the cane in the Nira Valley was still standing when the monsoon burst. That the value of power-crushers is becoming realized is proved by the fact that the number of private installations is regularly increasing. Eight enquiries were received in 1912-1913 and estimates were given for each by the Agricultural Engineer. This officer is of opinion that the type of horizontal mill driven by an oil-motor now recommended gives an output of at least 11 to 12 per cent. more juice than the old country mill. Not only does it extract so much additional juice from a given amount of cane, but in a given number of hours it can crush three times as much cane as the country mill. But perhaps its greatest

**Economy and efficiency of power-crushers.**

advantage lies in the fact that the cane-grower can crush his cane when it is most convenient to him without having to resort to bullocks and coolies at a time when they are in the greatest demand elsewhere. The quantity of cane crushed by most growers in this Presidency is insufficient to justify the initial cost and running expenditure of a steam mill and boiler; but at the same time growers might well consider the possibility of joining together to erect and run such a plant. In that case the Agricultural Engineer will be happy to give all the assistance in his power.

**Power oil-seed crushers.**

The arguments in favour of power-driven oil-seed crushers are similar to those in favour of power cane-crushers and need not be repeated. The Agricultural Engineer is paying special attention to this type of machinery, and hopes to be able to show results in a future report.

**Subsidiary cotton gins.**

The smaller cotton-growers not infrequently complain that they suffer considerable loss by not being able to gin their own cotton. The reason is that the large ginning mills not unnaturally do not devote much care to the small man's cotton. Enquiries have reached the Agricultural Engineer whether small ginning plants could not be worked by existing pumping engines, and he is of opinion that this could be done most advantageously, especially if other growers in the vicinity would send their cotton to be ginned. Here again a large field is open for co-operative effort.

**Wind-mills and flour-mills.**

Other types of machinery that are attracting attention are flour-mills and wind-mills. Power-driven flour and rice-mills already exist in some numbers in cities, small towns and even a few large villages, but it is obvious that they might be installed by individual cultivators or by several jointly with great advantage.

Enquiries regarding wind-mills have hitherto contemplated water raising only, but as very special conditions are essential for success, the Agricultural Engineer does not anticipate great things in this direction.

**Power-ploughs.**

It remains to discuss one of the most important forms of agricultural machinery which the Agricultural Department is endeavouring to introduce into this Presidency. The Agricultural Engineer soon after his appointment set himself to consider the possibility of ploughing and cultivating land by means of power-driven implements. The subject did not fail to arouse public interest, and in the two years 1910-1911 and 1911-1912 eleven enquiries were received from large landowners. At the end of the latter year Mr. Musto's investigations were made public in the shape of a bulletin (No. 54 of 1912) entitled "A note on Steam-ploughing", a perusal of which is recommended to all who contemplate installing a steam-ploughing plant. The chief obstacle to the introduction of steam-ploughing in this Presidency is that the initial outlay is very high, and well above the resources of most individual cultivators. But though the initial cost is heavy, the maintenance charges are not excessive, if the plant is fully occupied, and as it can be put to many uses, it should not be impossible to give it constant work. In the first place, it can plough large areas efficiently and rapidly; in the second, it can break up large areas of good fertile soil now lying waste and prepare it for cultivation by eradicating deep-seated weeds and grasses such as *hariáli;* and lastly, once ploughing and its subsequent operations are completed, it can be used for hauling, threshing, crushing and pumping. The Agricultural Engineer urged that an efficient plant should

**A bulletin issued.**

**What a steam-plough can do.**

be brought out from England and its use demonstrated by the Agricultural Department, and as a result a complete steam-ploughing set was ordered in 1912-1913 from Messrs. Fowler & Sons, who have a world wide reputation for this class of work. The necessary funds were provided by the Sir Sassoon David Trust Fund for agricultural and educational purposes. The plant arrived in September 1913 and was set to work in November at Rannebennur in the Dhárwár district in charge of a skilled engineer supplied by the firm. His Excellency the Governor paid a visit to the site and personally inspected the ploughing operations. A constant stream of visitors on that and three succeeding days testified to the interest which was being taken by the public.

The Rannebennur experiment.

Before taking up the actual work it was necessary to deal with certain preliminary difficulties, such as the arrangement of the land to be ploughed, providing the engines with suitable feed-water, and the training of local men who eventually could take charge of the tackle. It will be obvious that the task before the officers in charge of this project was not an easy one, especially as it had already been settled that it should be run on commercial lines and that the season's working should, if possible, show a profit. Special attention had to be given to details of organization to produce the result anticipated. However, during the first season, which was purely an experimental year so far as this Presidency is concerned, 770 acres were ploughed to a depth of 16 to 18 inches, and a profit of Rs. 607 was realized on the season's working after providing for interest, depreciation and the execution of repairs.

The results.

The experience gained proves conclusively that steam cultivation, when managed properly, not only rids the land of

the *hariáli* pest, but is also a profitable commercial undertaking. As a result of this success in the Dhárwár district Government have decided to purchase a similar set of tackle for Gujarát.

A motor-plough.

It has already been stated that this tackle is very costly as regards initial outlay and beyond the reach of ordinary cultivators. To meet the requirements of these men for ordinary ploughing, the Agricultural Engineer has recently ordered a motor-plough which will shortly be tested at the College Farm, Poona. Apart from its primary function of ploughing, this small motor should be useful for other work in the field, such as harrowing, hoeing, etc. If the experiments are successful, it is anticipated that great savings will eventually be effected by the adoption of this new implement.

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## CHAPTER V.

### ASSISTANCE TO THE PUBLIC.

The Agricultural Engineer prepares plans and estimates after survey *gratis*.

IT will be clear from the foregoing chapters that the branch of the Agricultural Department which is under the control of the Agricultural Engineer comes into contact with the public just as much as any other branch of the Department. It has already been explained that the Engineer is ready to give advice and if necessary to carry out surveys and prepare plans and estimates free of cost. This applies, not only to the erection of new plants, but also to the maintenance of old installations. An example of the latter is quoted in the Agricultural Engineer's last report. The pumping plant of a cultivator in the Ahmedabad district had got out of order owing to the engine

being taken down, cleaned and re-assembled by unskilful hands. For two days the owner had been trying to put it right, but without success. The Agricultural Engineer happened to be there in connection with some boring operations, went to his assistance, and put it right in 30 minutes. When the workshop and training school described in Chapter I are in full working order and trained men are available for employment both by the Department and by private owners, such mistakes will seldom occur, and, if they do, will be easily remedied.

**He will also do erection work on business terms.**

It has also been mentioned that the Agricultural Engineer will actually do erection work for private individuals, if they so desire, on business terms. The procedure adopted is as follows :—If, after the Department has furnished plans and estimates, the enquirer wishes to act on the advice given and to have the work done by the Department, he is required to pay, before the work is begun, such a sum as will cover the cost of the plant and the necessary sundries, and also a charge for erection, which is fixed roughly in proportion to the amount of the estimate and work to be done. This charge is usually less than the actual cost to Government, and never more. Full drawings are then prepared, and the machinery and sundries are purchased and erected by the Department, the enquirer providing all building materials and labour for the same. The machinery is eventually started and handed over in good working order to the owner, and the Agricultural Engineer is afterwards always ready to give further advice and effect repairs if possible. But he obviously cannot take responsibility for the working of the plant, which necessarily is left entirely in the owner's hands.

**Procedure.**

Accounts.

An account of all private money received is kept in the following manner:—Directly any money is received the Agricultural Engineer pays it into the Bank of Bombay, and an account is opened for the owner of the particular site and the machinery under construction. He then proceeds to draw cheques as needed on this account in order to pay for the machinery ordered and to meet any other expenses that may occur during erection. After the work is complete, a detailed account of payments in connection with each item is made out and sent to the owner, together with the balance, if any, due to him. The invoices and bills are kept in the Engineer's office and are available for inspection at any time.

Well-boring rules.

The rules for well boring have until quite recently been based on commercial lines. The work was carried on by advances from the Director of Agriculture, and the well owner paid after the work was completed, mainly according to results. New rules, however, are now in force, which entirely dispense with the system of advances, and, although the cultivator pays for the coolies, he does not pay for the *mukádam* unless a good supply of water is tapped. Needless to say, these rules are rapidly becoming popular.

Advantages accruing to the Department and clients.

By entrusting work to the Department cultivators are sure of certain advantages. In the first place, most firms which supply agricultural machinery quote special trade rates to the Agricultural Engineer, and as Government makes no profit out of the transaction, the cultivator thus gets his machinery at the lowest possible price. Next, the Agricultural Engineer takes the responsibility of designing the plant and of ordering, receiving, erecting and testing the machinery. He is naturally much interested in the success of his work, and takes particular pains to make his schemes

give the best possible results. But it must also be realized that he will not erect any machinery for all and sundry. He must first be convinced that it can be employed profitably and that there is a reasonable chance of its being tended properly. Broadly speaking, the policy adopted is to advise and assist those who have some sense of self-help and of business-like methods, and to prevent their purchasing unsuitable machinery, but not to bolster up an artificial industry by thrusting gifts on the helpless and unenterprising, who will not or cannot take due advantage of them. It is useless for a man to own machinery unless he has some intelligence, a good deal of industry and sufficient capital to make the best possible use of his intelligence and industry; and where these conditions are lacking, the Agricultural Engineer never recommends the purchase of plant.

Policy adopted.

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